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Rearrangement of the Cytoskeleton in Triticum aestivum Cells during Cold Hardening and after Treatment with Abscisic Acid

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Abstract

Immunocytochemical study of the basic characteristics of the tubulin and actin cytoskeleton (total content, orientation, structure, and stability) was performed for various root zones of the seedlings of winter wheat cultivars contrasting in their freezing tolerance. Plant cold hardening (3°C, 7 days) and ABA treatment (30 μM, 3 days) increased the stability of tubulin microtubules (MT), that is, reduced the depolymerizing action of oryzalin in vivo. However, the mechanisms of hardening and ABA stabilizing action on the cytoskeleton were different: low temperature enhanced spatial MT aggregation and resulted in the formation of a dense network of thick MT bundles, whereas ABA reduced the content of tubulin components and induced microfilament (MF) depolymerization. Most pronounced temperature- and ABA-induced cytoskeleton changes were observed in the differentiation zone, which indicates an important role of this root zone in plant adaptation and development of root freezing tolerance. Low temperatures reduced the hormonal effect on the structural arrangement and stability of MT and MF in wheat cultivars of high and moderate freezing tolerance but increased hormonal effects in the slightly tolerant cultivar. MF depolymerization and an increase in the proportion of stable MT are supposed to be a necessary condition for seedling growth retardation after their treatment with ABA and for seedlings at the initial phase of their adaptation to low temperature. At the final phase of cold hardening, some growth acceleration is evidently determined by the accumulation of highly labile MT and greater actin polymerization.

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Keywords

ABA, Cold hardening, Cytoskeleton, Microfilaments, Microtubules, Triticum aestivum